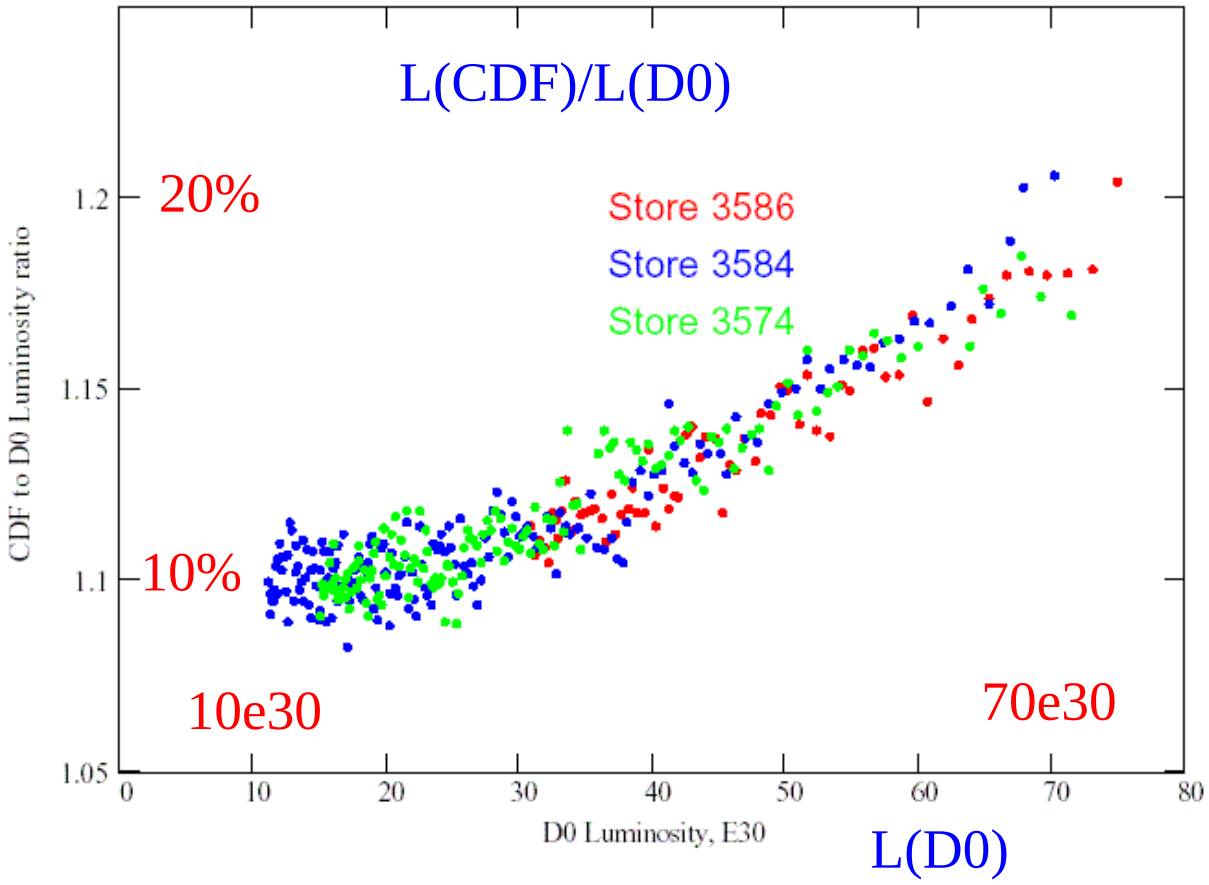
CDF/DØ Luminosity Disparity

Brendan Casey

All Experimenters Meeting, September 27, 2004

CDF/DØ Luminosity



DC component:
Order 10% difference at low luminosity

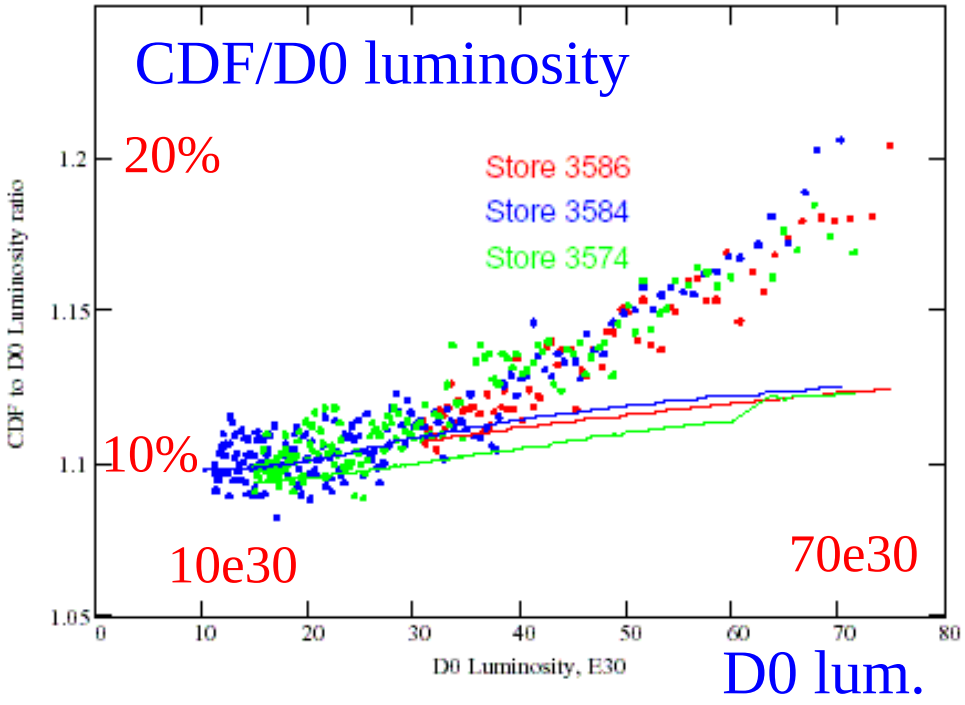
AC component:
Order 10% variation in the ratio as a function of lum.

Note that CDF luminosity seems at least 10% higher in these stores.

CDF and DØ are using the same inputs for lum. calc. All (known) major luminosity dependent effects are taken into account.

AC Component: Beams Division

Several detailed studies performed.



β^* ratio: 27.5/35

$\sim$ 2% change due to hourglass effect

Valeri Lebedev

Conclusion: AC components exist but at the few % level.
Has to be a problem with the experiments.

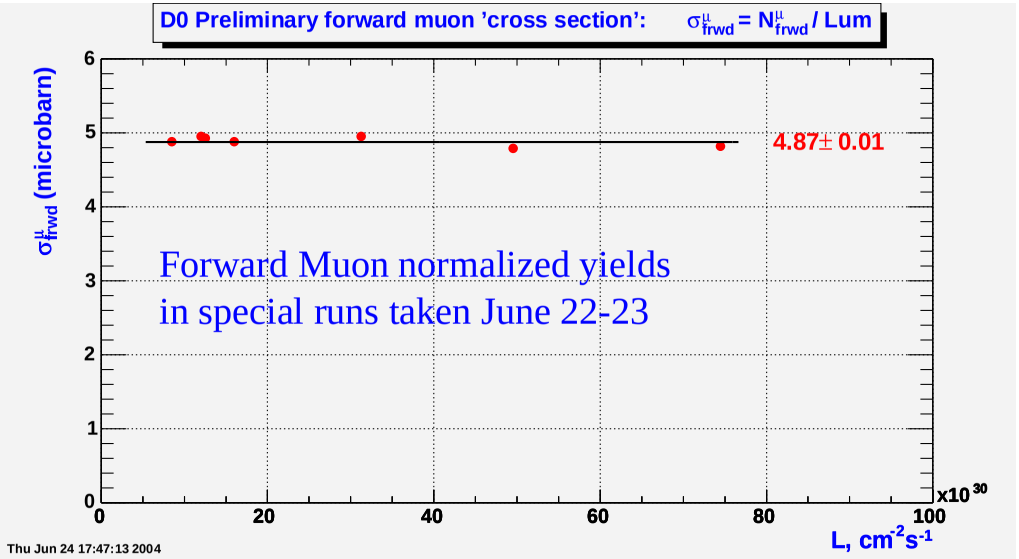
AC Component: DØ

Checked stability of cross sections:
Forward muon + others

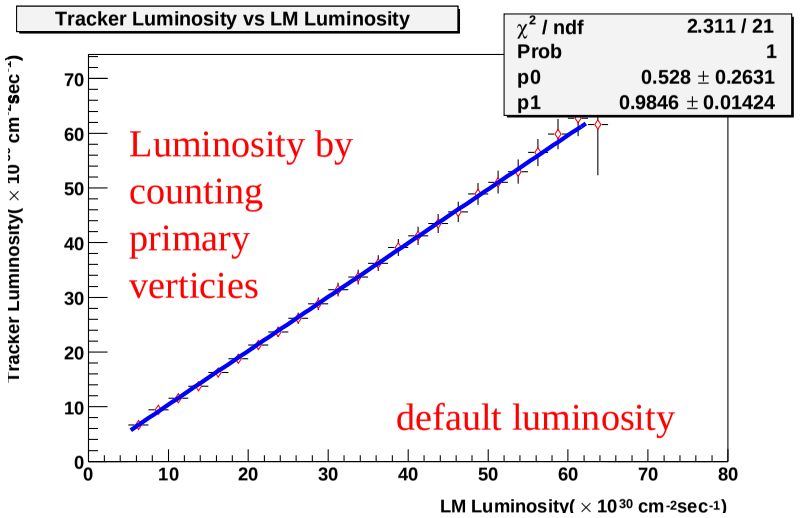
Made independent determination of luminosity with tracker

Luminosity efficiency determination included dedicated studies for luminosity and tick dependence.

Conclusion: DØ luminosity is fine.



D. Denisov, A. Ferapontov, A. Shchukin



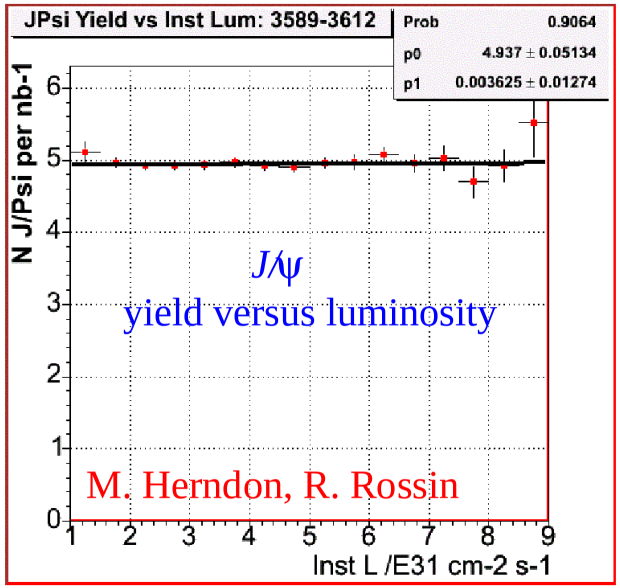
P. Mal, A. Nomerotski, S. Choi, BC

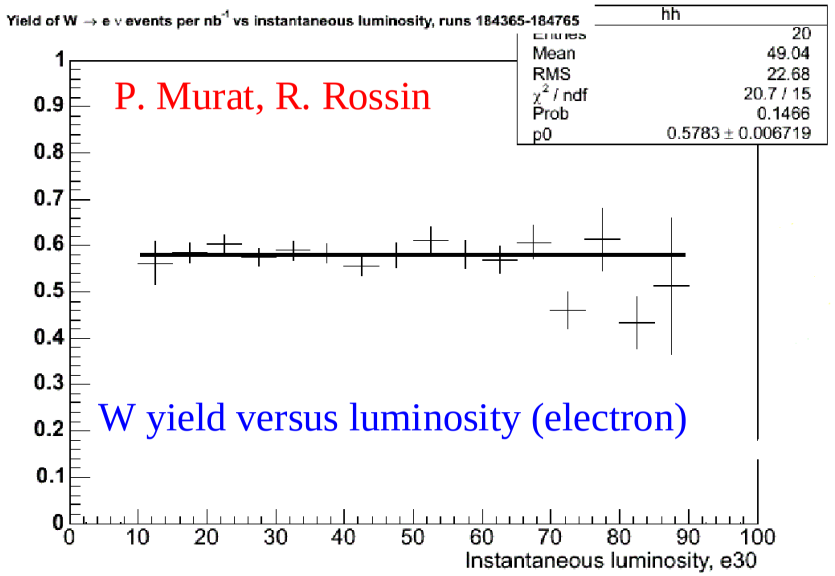
AC Component: CDF

Similar studies
J/ψ yields,
$W \rightarrow e\nu$ yields...

plus very detailed studies/simulations at the detector level of response versus luminosity

Conclusion: CDF luminosity is fine.





More Cross Checks

Only known luminosity dependent problem was order % effect from silicon detector readout noise.

Luminosity would change by about % when we started reading out silicon at very high luminosities.

To study this required plugging and unplugging things into the electronics at high luminosity during a store: never done before for obvious reasons.

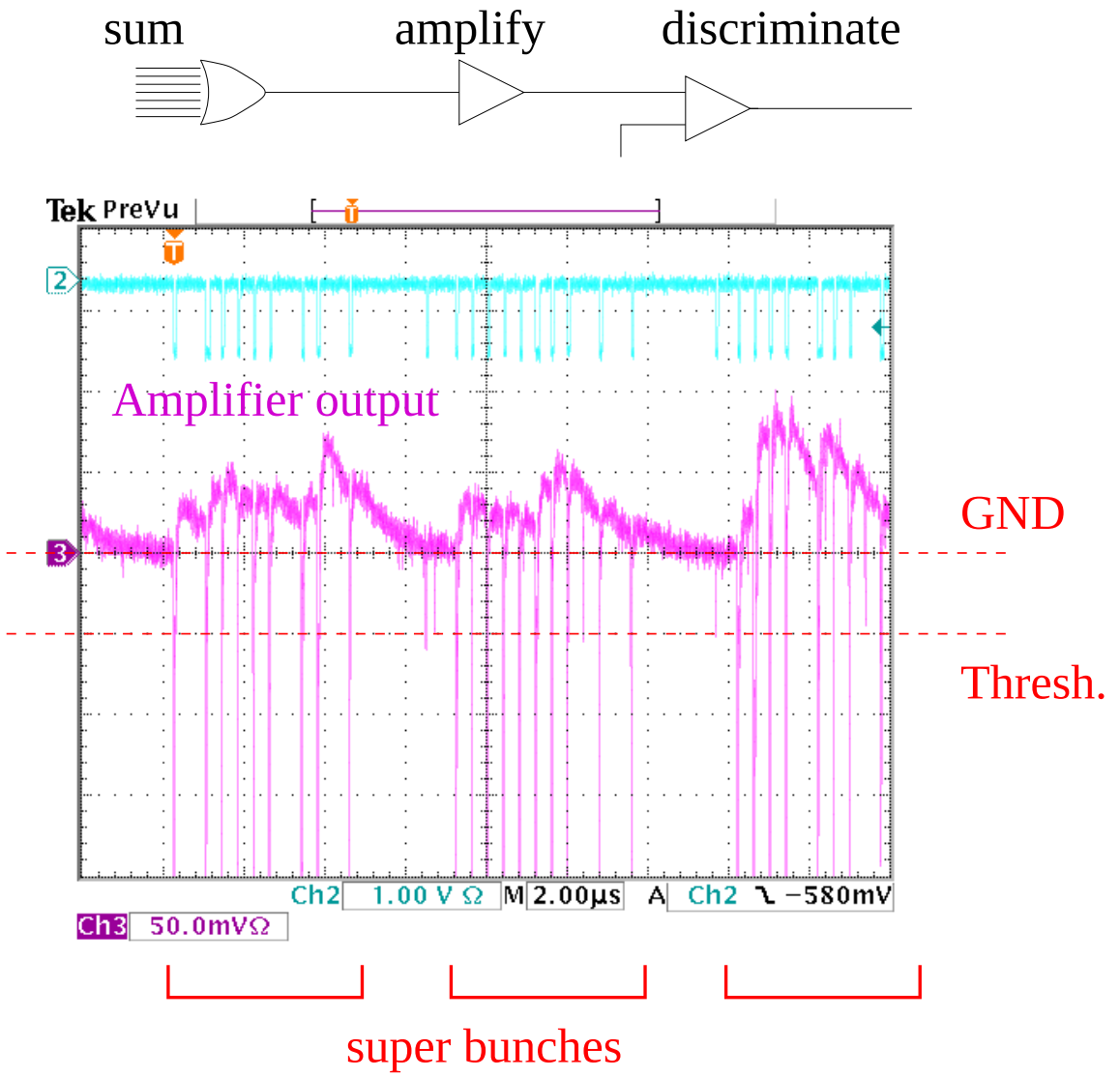
Baseline Shifts

Found baseline shifts on the order of 1-2 times threshold

shift depends on interactions in previous bunches

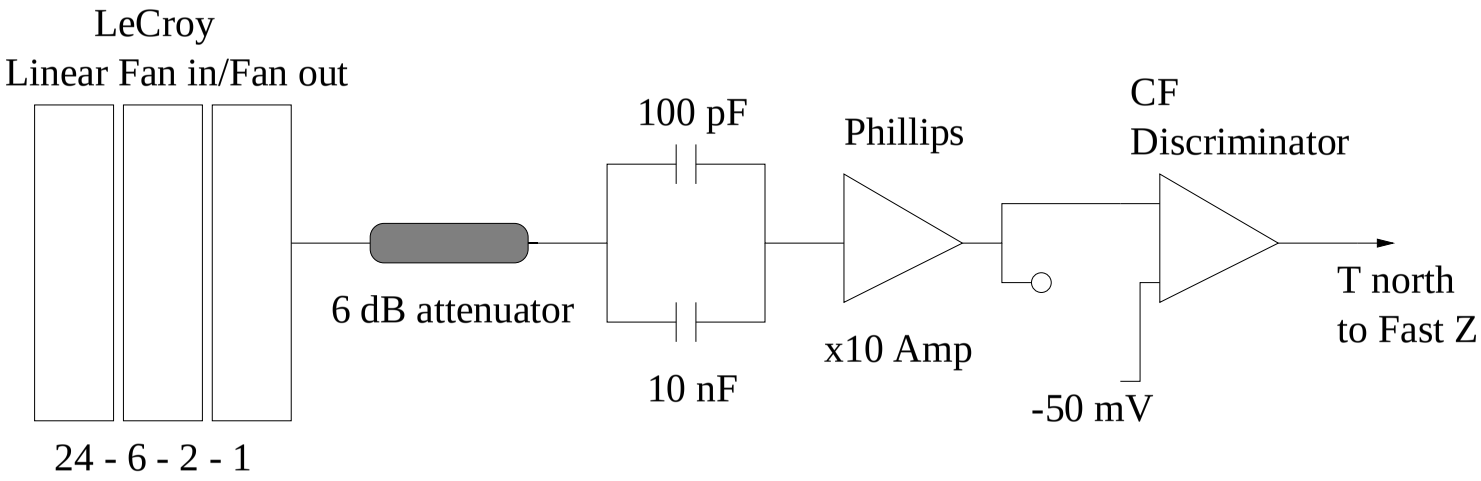
⇒ tick and Lum dependent

baseline restored between super bunches



shifting baseline $\Rightarrow \frac{\Delta L}{L} \sim L$

AC Coupling



Signals are AC coupled between fan-in/fan-outs and amplifier
$\Rightarrow$ average baseline is GND at input to the amplifier

Average current accumulated by the PMT is proportional to Lum.

The amplifier must sink an equal and opposite current to maintain AC coupling.

Restoration time given by the RC time constant $\sim 1\mu$s
$\Rightarrow$ way too long for 396 ns bunch spacing.

Cross Checks Revisited: Muon

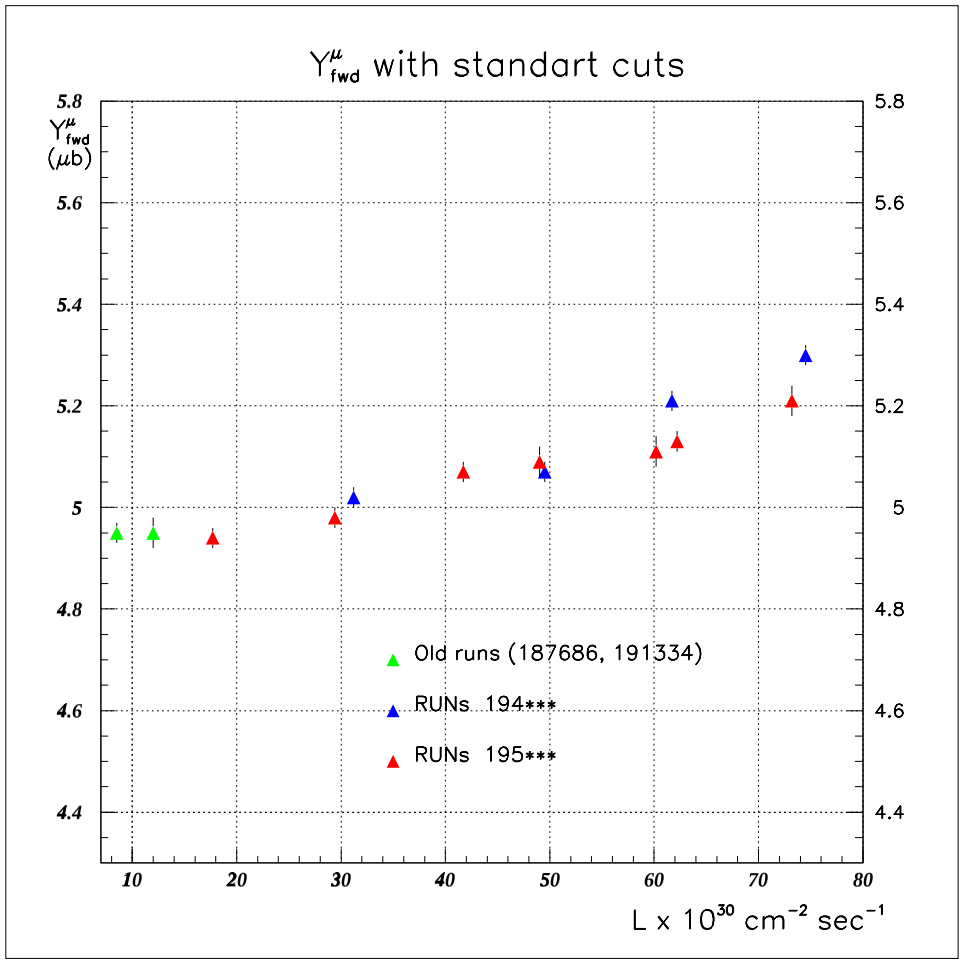
Processing problems with first set of runs

more special runs taken

old special runs redone

dedicated efficiency, fake rate study (both flat)

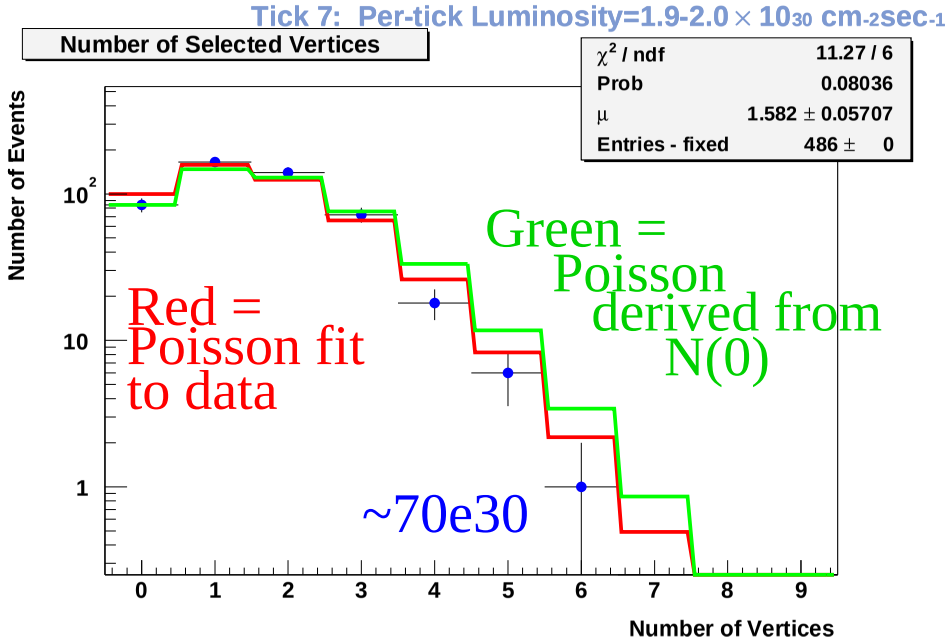
quadratic dependence clearly seen

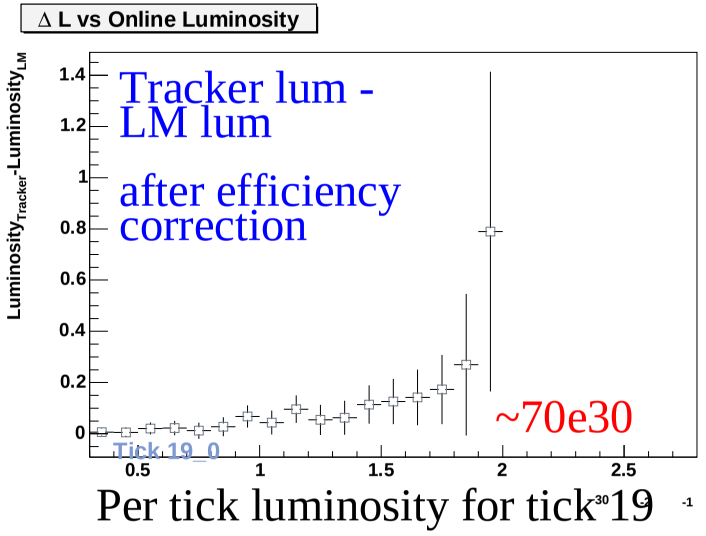


A. Popov, D. Denisov, A. Schukin

These problems were discovered by Muon people independently of the baseline shift problem.

Cross Checks Revisited: Tracking



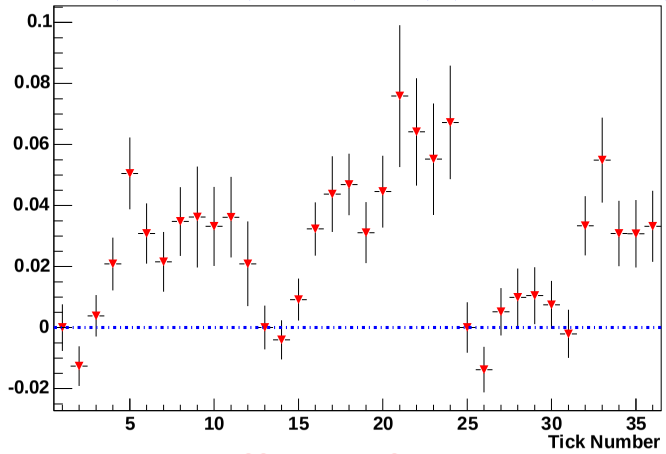


$$\epsilon_{PV} = \epsilon_{PV}(N_{int})$$

had checked with MC but effect is not seen in MC

Only possible to see after adding Summer 04 high luminosity data.

Fit to: L(tracker) = L(LM)(1 + cL(LM))

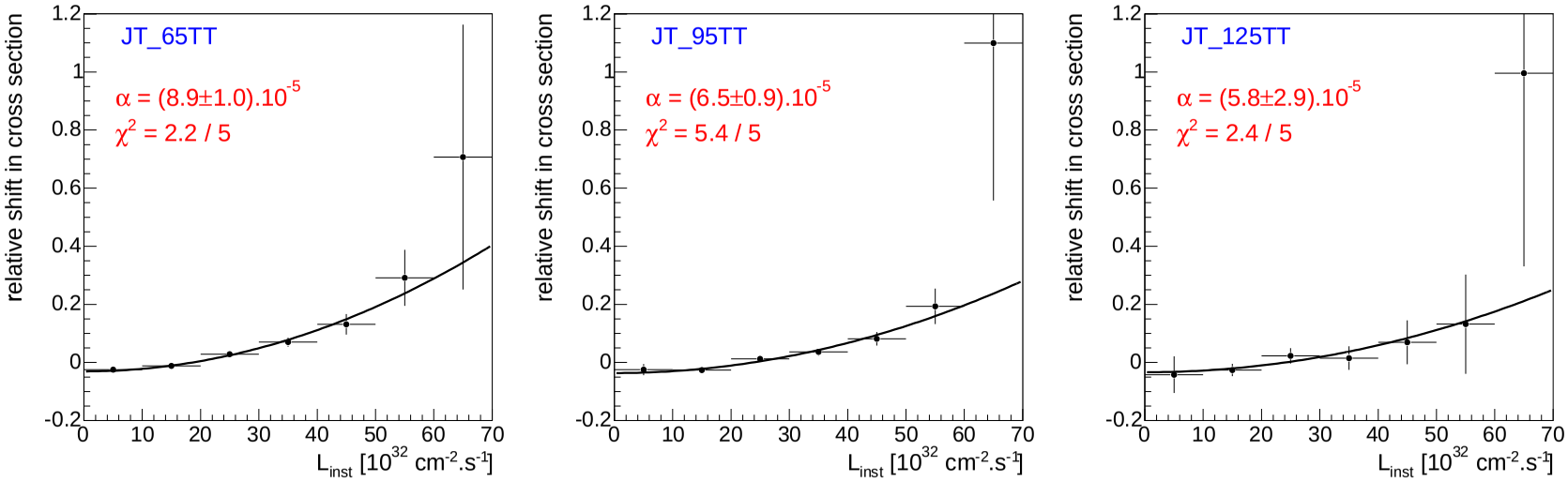


quadradic coefficient for each tick

quadratic effect clearly seen.

New Cross Checks: Jets

dependence on L_{inst} - some post Apr 20 data



$$\mathcal{L}_{true} = \mathcal{L}_{reported}\left[1 + \alpha \mathcal{L}_{inst}^2\right] \qquad \alpha \sim (7.5 \pm 1.0).10^{-5}[10^{-60} cm^2 \cdot s]$$

- NO RUN SELECTION (only calorimeter bad LBNs)

A. Kupco quadratic dependence clearly seen

Preliminary Correction

Tried several things in last few stores to try and fix the problem

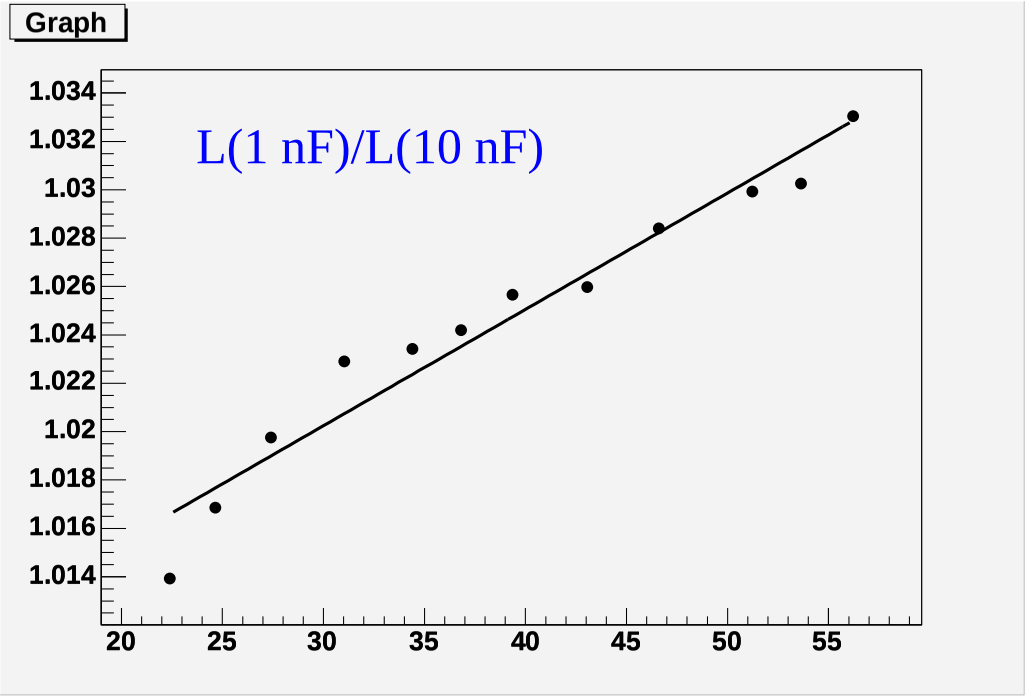
best results from replacing 10 nF cap with 1 nF cap

$\Rightarrow$ factor of 10 reduction in time constant

$$\frac{L_{\text{true}}}{L} = \alpha(1 + \beta L)$$

parameters determined from

$L(1\text{ nF})/L(10\text{ nF})$



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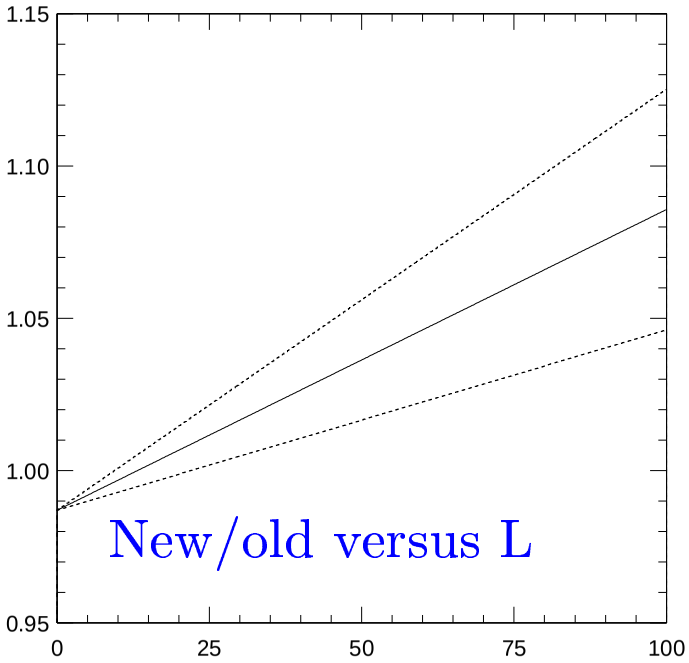

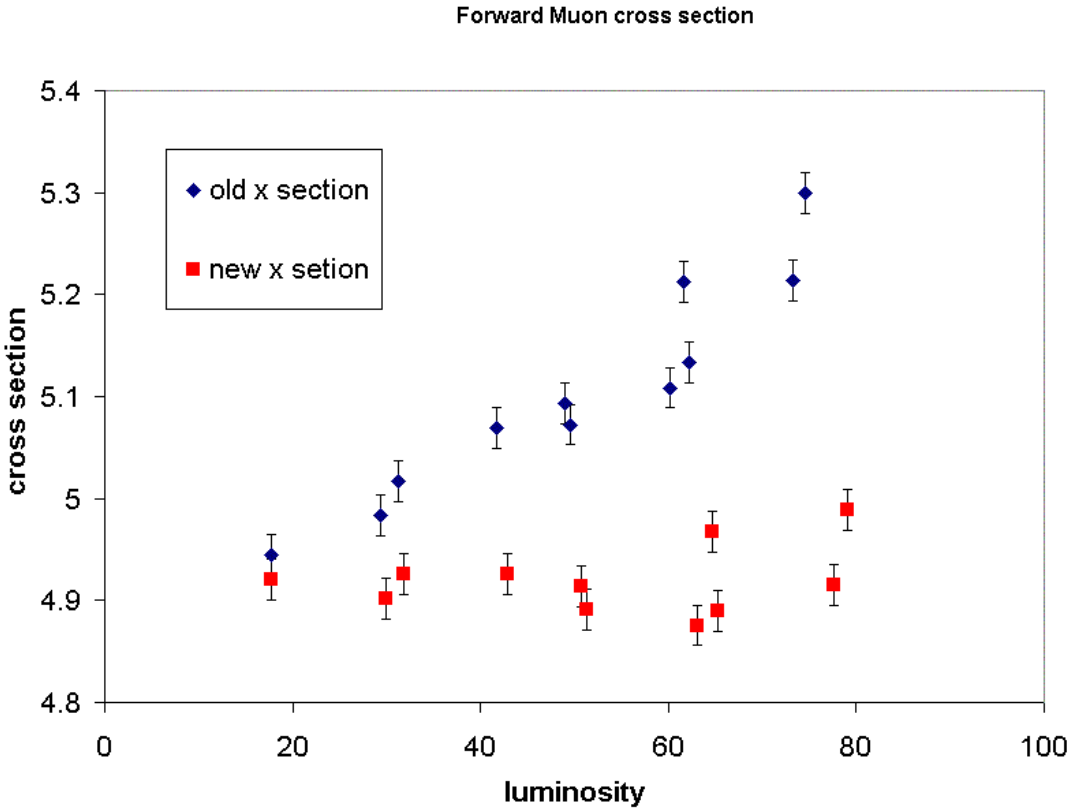

Preliminary correction indicates most of the AC component can be explained by this problem

still a large uncertainty in the correction that will not be reduced until we have more high luminosity data

Effects on Integrated and Peak Luminosity

Store	Old Lum (e30)	New lum (e30)
3214	52.5	54.2
3261	64.1	66.9
3562	71.0	74.6
3621	84.3	89.7
3657	93.6	100.4

Average instantaneous luminosity of data sample is $\sim 30e30$

at this level, correction is below 1%

basically no change to the integrated delivered luminosity

Plans

- Come out of the shutdown with the problem fixed.
  - already intended on integrating new upgraded electronics after shutdown
  - have designed and tested active baseline restoration circuits to fix problem in the current electronics.
- determine a better correction for old data using new high luminosity data.

Conclusions

It has always been the highest priority to ensure we are making an accurate luminosity measurement. This is continuously monitored online and offline.

Unfortunately, we got very unlucky with three canceling effects leading to two flat ratios that indicated our luminosity measurement was robust. This lead us to make incorrect statements about the accuracy of our measurement.

Biggest obstacle in understanding the difference between CDF and DØ luminosity is behind us. Attention can now be shifted to understanding the DC component (not fixed by this problem).

Tevatron now has a new record luminosity.